Space Weather Technical Forecast

Issued on Sunday, 08 September 2024 at 00:20 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of G1 Minor Storms Day 1 (08 Sep). M-class flares remain likely throughout.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Moderate with one long period M-flare peaking M1.6 from AR3813 and an associated filament eruption at 07/0746 UTC. There are ten sunspot regions on the disc. This includes AR3813 in the south-centre and AR3815 in the southwest, which comprise of a broad and connected complex of relatively small spots. However some simplification appears to be occurring with AR3813 having seen a previous delta spots now fade, although SDO imagery continues to show magnetic looping between these regions. AR3811 in the southwest is a further region that has some connection to these spots, with a mobile filament between them, but also remains relatively simple. The only notable growth observed was in AR3814 in the northwest with the development of a small trailer and peripheral spots. AR3806 and AR3808 in the southwest also have some flare potential, with the latter small but with a weak delta spot, however these are both becoming hard to assess due to their increasing viewing angle.

A sequence of recent filament eruptions CMEs, two from near AR3813 and another off the southwest have been assessed as passing well to the south of Earth. All other CMEs that have been observed are off the Earth-Sun line.

Solar Wind / Geomagnetic Activity: Slow wind conditions persisted at L1 with observed solar wind speeds by ACE and DSCOVR easing from slightly elevated, at just over 400km/s to be at background at below 350km/s. Density was generally below average. Interplanetary Magnetic Field, Bt, was Weak to Moderate, in the range 7-11nT, with north-south component, Bz, variable in direction and in the range -7nT to +9nT. Phi angle was mainly negative (towards the Sun). Geomagnetic activity was Quiet (Kp1-2).

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux observed by GOES18 continued easing after the slight, but below S1 Minor Radiation storm, enhancements since 01 Sep, but remained just above background. High energy electron flux (greater than 2MeV) observed by GOES16 was mainly Background, but briefly Moderate between 07/1250-2000 UTC with peak 296 pfu at 07/1435 UTC. The associated 24-hour fluence remained below the Active threshold, with 4.8e6 integrated pfu observed at 08/0000 UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Moderate activity is forecast with M-flares likely through the period, but with a slight chance of isolated X-class flares.

Solar Wind / Geomagnetic Activity: There are no Earth-directed CMEs. CH65/+ fast wind onset is likely on day 1 (08 Sep) with slightly elevated solar winds expected. Any elevated solar winds likely easing day 2 onward (09 Sep). A spell of Active geomagnetic activity with a chance of G1 Minor Storms is likely with the onset. Otherwise mainly Quiet with isolated Unsettled spells expected.

Energetic Particles / Solar Radiation: High energy proton flux is expected to continue easing towards background, but with a slight chance of further enhancements from any notable flares,

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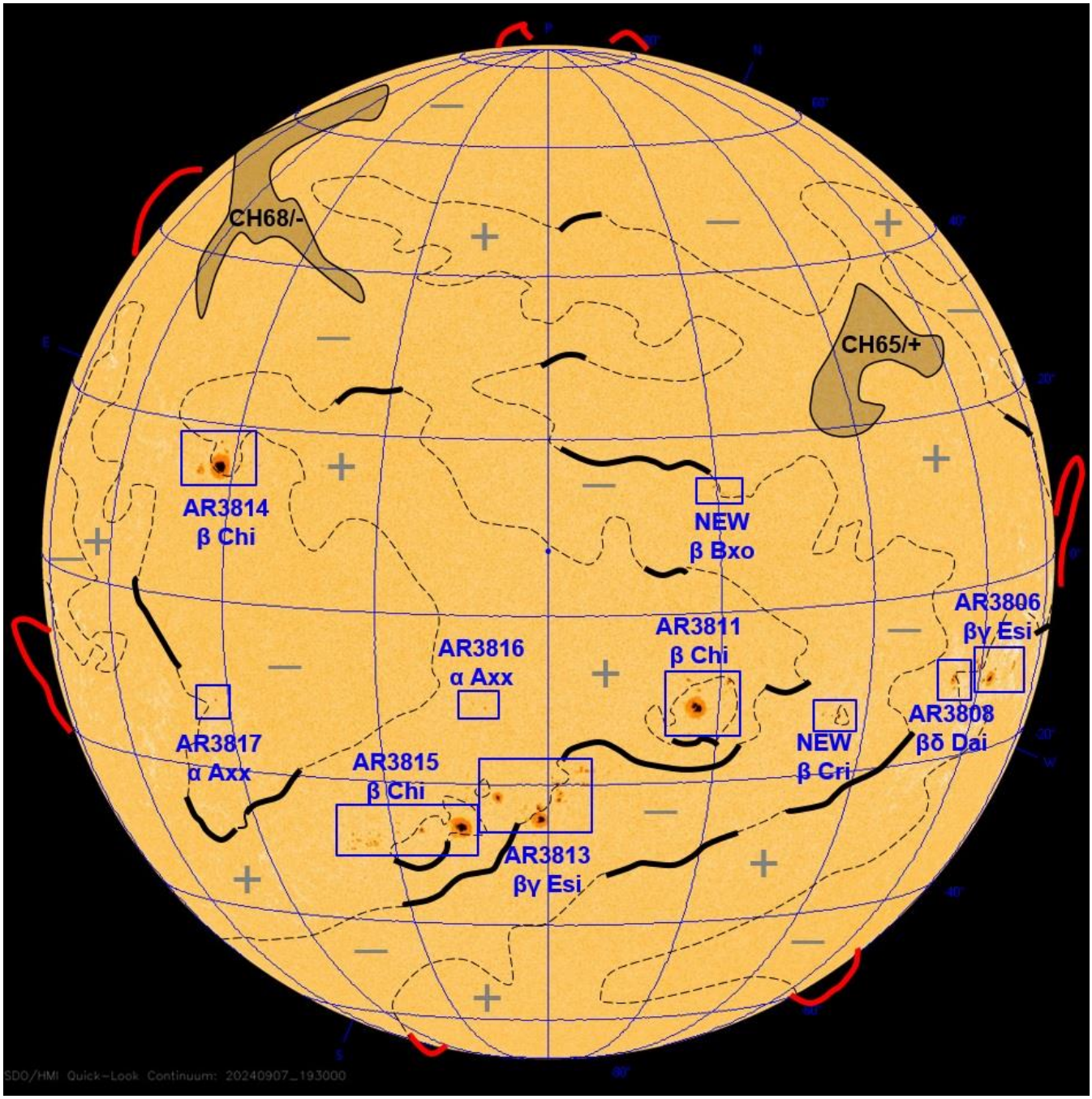
perhaps increasing slightly as the south-centre regions move across the western disc. High energy electron flux is expected to be Background to Moderate, with an increasing trend later in the period, perhaps giving periods of High at diurnal maximum. The associated electron fluence is forecast to have a rising trend, but is currently expected to stay below Active.

Figure 1. Solar Analysis Valid 07/2000 UTC.



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Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

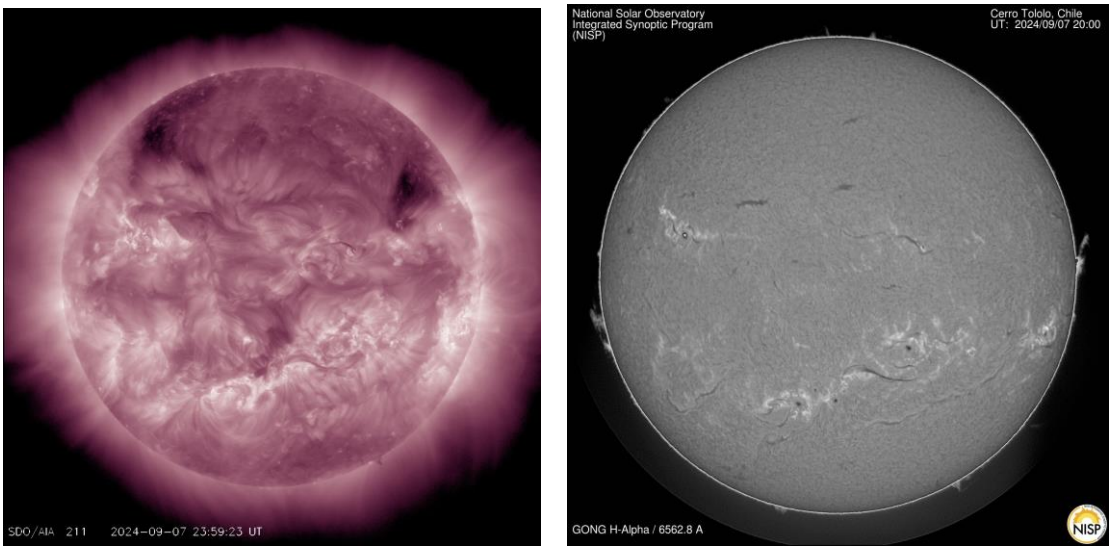
There are no Earth-directed CMEs. Filament eruption CMEs on 06 and 07 Sep have been assessed as directed too far south to be observed when passing 1 AU. However, a number of filaments are situated on the southern-centre disc, including a mobile filament between AR3811 and AR3813, and provide a potential for further CMEs.

Slow wind conditions at first, with background speeds, are likely to be soon followed by a connection to the fast wind from CH65/+ in the northwest disc. This is most likely to occur during day 1 (08 Sep) with solar winds becoming slightly elevated and geomagnetic activity increasing with a spell of Active with a chance of G1 Minor Storm intervals likely. This easing back to mostly Quiet with Unsettled intervals from day 2 (09 Sep) onward.

This coronal hole on the previous rotation was in a slightly different location, and the solar wind was contaminated by CME arrivals, so persistence forecasting is not reliable. Furthermore MOSWOC Enlil continues to significantly overestimate current solar wind speeds, modelling a broad and strong coronal hole which does not exist, and lowering the confidence in the forecast. However, the coronal hole being of positive polarity it is more likely to give a notable geomagnetic response at Earth at this time of year (Russell-McPherron effect).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	30	5	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Figure 2: SDO aia-211 (left) and GONG H-alpha showing a large number of filaments (right)



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Radio Blackouts - X-Ray Flares:

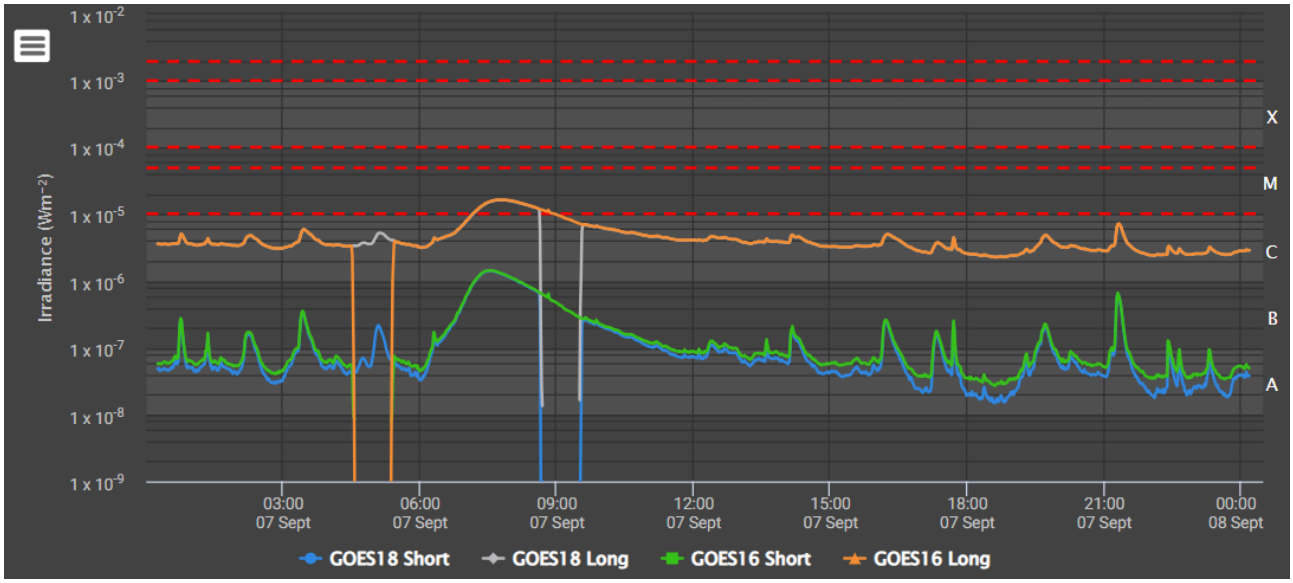
Moderate activity is expected with a slight chance of rising to High. There are ten sunspot regions on the disc, with a few notable areas of potential flares, albeit currently remaining largely inactive

The most notable include the southern central complex of AR3811, and more notably AR3813 and AR3815. These form a string of smaller spots, with some interconnection evident from both filaments stretching across these regions, but also in SDO imagery. AR3813/AR3815 was also the source of a notable eruptive event from the southeast limb on 01 Sep. Despite this, each individual region appears relatively simple, with some sign of decay, and with AR3813 also recently losing its delta spots. However given the history of these regions, and the overarching magnetic structure, further notable flares remain possible.

Other regions of note include AR3806 and AR3808 in the southwest, the later very small but with a delta spot, however these are becoming harder to assess as they approach the southwest limb. AR3814 in the northeast is perhaps the most notable growing region, with recent trailer spot developing, but currently remains relatively inactive.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	70	70	70	70
Very Active	R3 to R5 X Class	No	10	10	5	5

Figure 3: GOES-16/18 X-ray flux



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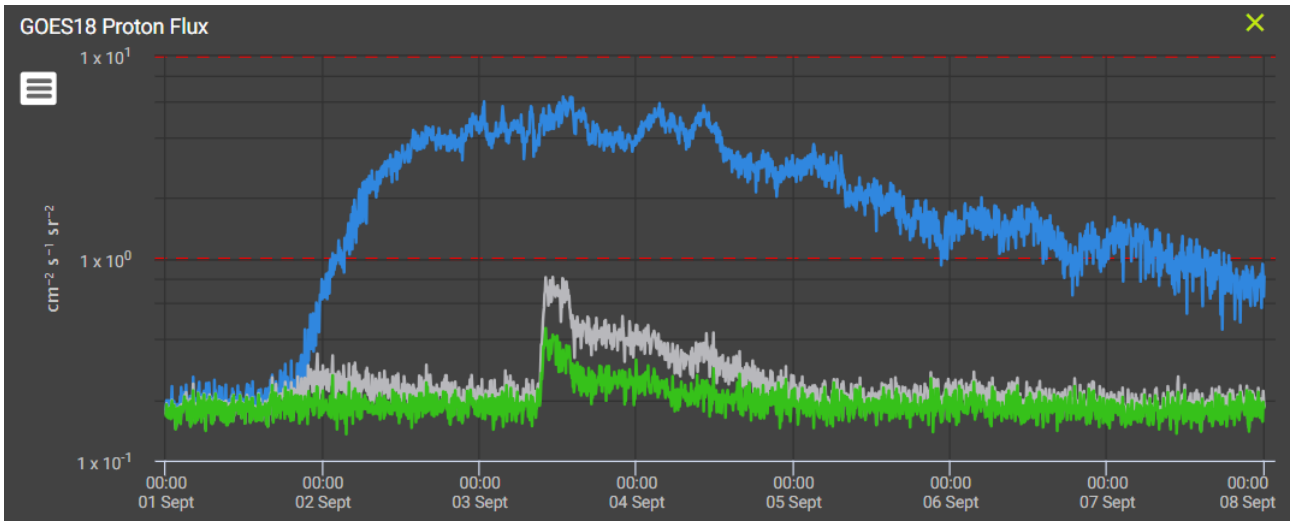
Solar Radiation Storms - (High Energy Protons):

High energy proton flux, as observed by GOES-18 is currently easing back towards background, and this is expected to continue through the period. The recent below S1 Minor Radiation storm level enhancement was from the 01 Sep M5.5 flare on the SE limb, but further contributions likely from the far-side eruption from over the NW limb on 03 Sep that also saw a notable response at higher energies (greater than 50 and 100 MeV).

There is currently only a very slight chance of further events that would lead to proton flux at GEO rising above the S1 Minor Radiation storm threshold. However, this chance does rise a little later in the period when the sunspots regions currently in the south-centre disc move to a more geoeffective location.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	10	15	15
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: GOES-16 Proton flux (>10 MeV, >50MeV and >100 MeV) since 01 Sep At least two enhancements shown, with 01 Sep from SE limb eruption, and a harder event with >50Mev and >100MeV on 03 Sep, from over NW limb



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High Energy Electrons Event (≥ 2MeV):

High energy electron flux as observed by GOES-16 has been Background to Moderate. Onset of any fast wind may initially lead to flux levels becoming more persistently background for a time, but a recovering is likely later day 2 and beyond. Given the potential for a reasonable connection to CH65/+ fast winds, some charging of the Van Allen belts is likely, and this may bring spells of High flux at GEO during the observed diurnal peak by days 3-4 (10-11 Sep).

Overall, the 24 hour fluence is expected to remain below the Active (1e8 integrated pfu) threshold, although a rising trend is likely late in the period, perhaps giving a very slight chance of approaching this level.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	1	5	10
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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